



## A new species of torrent catfish, *Liobagrus hyeongsanensis* (Teleostei: Siluriformes: Amblycipitidae), from Korea

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### Abstract

A new species of torrent catfish, *Liobagrus hyeongsanensis*, is described from rivers and tributaries of the southeastern coast of Korea. The new species can be differentiated from its congeners by the following characteristics: a small size with a maximum standard length (SL) of 90 mm; body and fins entirely brownish-yellow without distinct markings; a relatively short pectoral spine (3.7–6.5 % SL); a reduced body-width at pectoral-fin base (15.5–17.9 % SL); 50–54 caudal-fin rays; 6–8 gill rakers; 2–3 (mostly 3) serrations on pectoral fin; 60–110 eggs per gravid female.

**Key words:** Amblycipitidae, *Liobagrus hyeongsanensis*, New species, Endemic, South Korea

### Introduction

Species of the family Amblycipitidae, which comprises four genera, are found in swift freshwater streams in southern and eastern Asia, ranging from Pakistan across northern India to Malaysia, Korea, and Southern Japan (Chen & Lundberg 1995; Ng & Kottelat 2000; Kim & Park 2002; Wright & Ng 2008). Four species are endemic to the Korean peninsula: *Liobagrus andersoni* Regan, 1908, *L. mediadiposalis* Mori, 1936, *L. obesus* Son, Kim & Choo, 1987, and *L. somjinensis* Park & Kim, 2010. In a recent examination of populations of *L. mediadiposalis* in rivers and streams in Korea, we found evidence that populations restricted to rivers flowing to the eastern coast belonged to a distinct, unnamed species, which is described herein as *Liobagrus hyeongsanensis*.

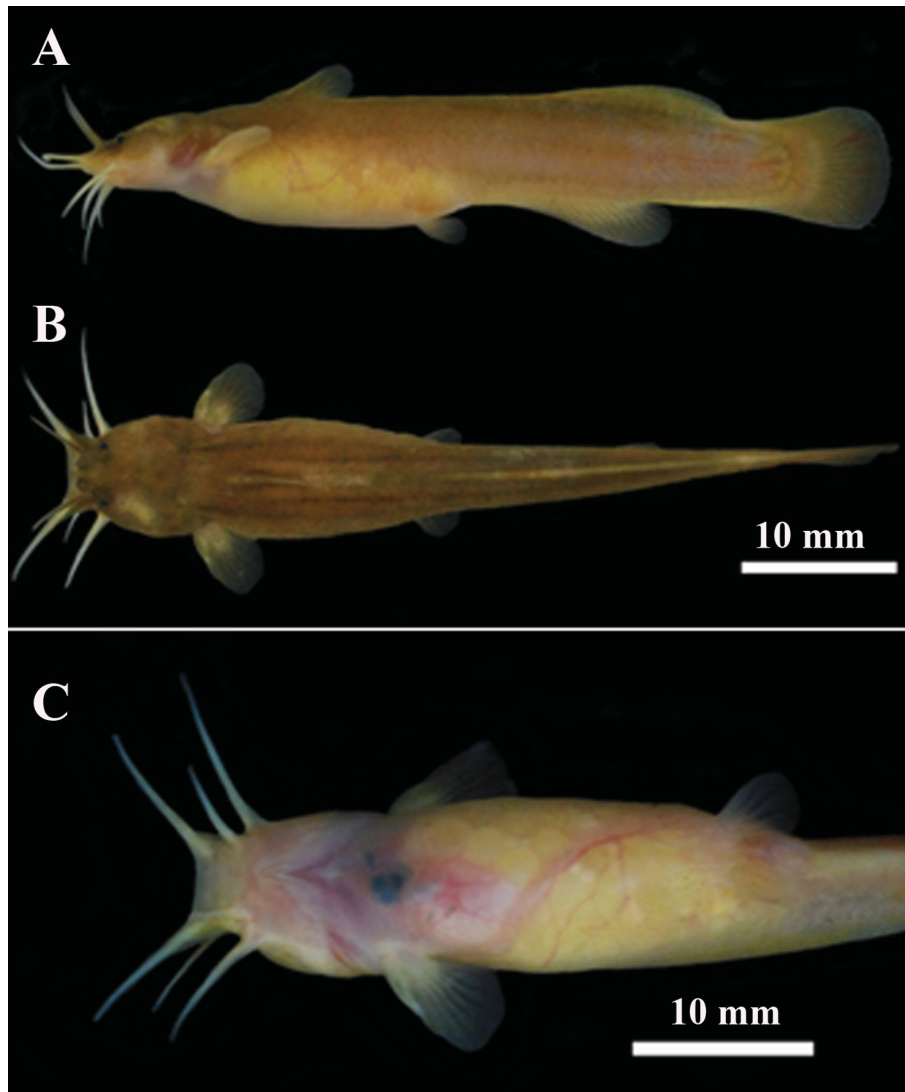
### Material and methods

Counts and measurements were taken following the procedures of Hubbs & Lagler (1964) and Wright & Ng (2008). Fin spines and soft rays were counted from radiographs, with the last two elements of the dorsal and anal fins being counted as one ray. Vertebral counts were also made from soft X-ray photographs (HA80, HITEX, Japan), with the three components associated with the Weberian apparatus being excluded (Chen & Lundberg 1995; Zhao *et al.* 2004). Measurements were taken using a digital caliper (to the nearest 0.1 mm). All specimens were deposited at the Faculty of Biology, Chonbuk National University, Jeonju, Korea (CNUC).

### *Liobagrus hyeongsanensis* sp. nov.

(Fig. 1)

**Type material.** Holotype: CNUC 38547, 84.1 mm standard length (SL); Hyeongsan River, Yangbuk-myeon, Gyeongju-si, South Korea, 35°49'58"N 129°24'41"E; J.Y. Park & S.H. Kim, 2 June 2013.



**FIGURE 1.** *Liobagrus hyeongsanensis*, **sp. nov.**, CNUC 38547, holotype, 84.1 mm SL, Hyeongsan River, South Korea.

Paratypes: CNUC 38548–38567 (20), 57.1–84.1 mm SL; same data as holotype.

Nontypes: CNUC 38830–38854 (25), 41.8–67.8 mm SL; Bukcheon River, Hwangnyong-dong, Gyeongju-si, South Korea; J.Y. Park & S.H. Kim, 28 March 2010.

**Diagnosis.** *Liobagrus hyeongsanensis* is distinguished from all its congeners by a small size (a maximum of 90 mm SL, vs. 150–180 mm); a smaller number of eggs per gravid female (60–110 vs. 130–210); and a smaller number of serrations on the pectoral fin (2–3, mostly 3, vs. 3–6 or 0–3, smaller or vestigial); a slenderer body width at pectoral-fin base (15.5–17.9 % SL, vs. 17.1–21.9%); a relatively short pectoral spine (3.7–6.5 % SL, vs. 6.8–13.1%). The lower jaw is shorter than the upper jaw (vs. longer or equal), and the body and fins are entirely brownish yellow without any other markings (vs. a vertical broad yellowish crescent-shaped band on the caudal fin or black or whitish yellow outer margins of the dorsal and anal fins).

**Description.** Meristic and morphometric data are provided in Table 1. Asterisks indicate meristic values for holotype. Maximum size not exceeding 90 mm standard length. Body thin, compressed, and round; head depressed, caudal peduncle vertically depressed; dorsal and ventral profiles of body straight. Predorsal profile slightly sloping ventral from dorsal fin to occiput. Head depressed, broad. Eye small, dorsolateral, subcutaneous, ovoid. Snout rounded in dorsal view. Anterior nostril tubular, rim with fleshy flap forming short tube; posterior nostril porelike, rim posteriorly confluent with base of nasal barbel. Lateral line absent or vestigial.

Mouth terminal; lips thickened, papillate, premaxillary and mandibular toothpads curved, teeth small and ciliiform or setiform, with upper jaw slightly longer than lower jaw. Four pairs of barbels: maxillary barbel longest, reaching base of pectoral spine; nasal barbel short, not reaching posterior margin of preoperculum; lateral

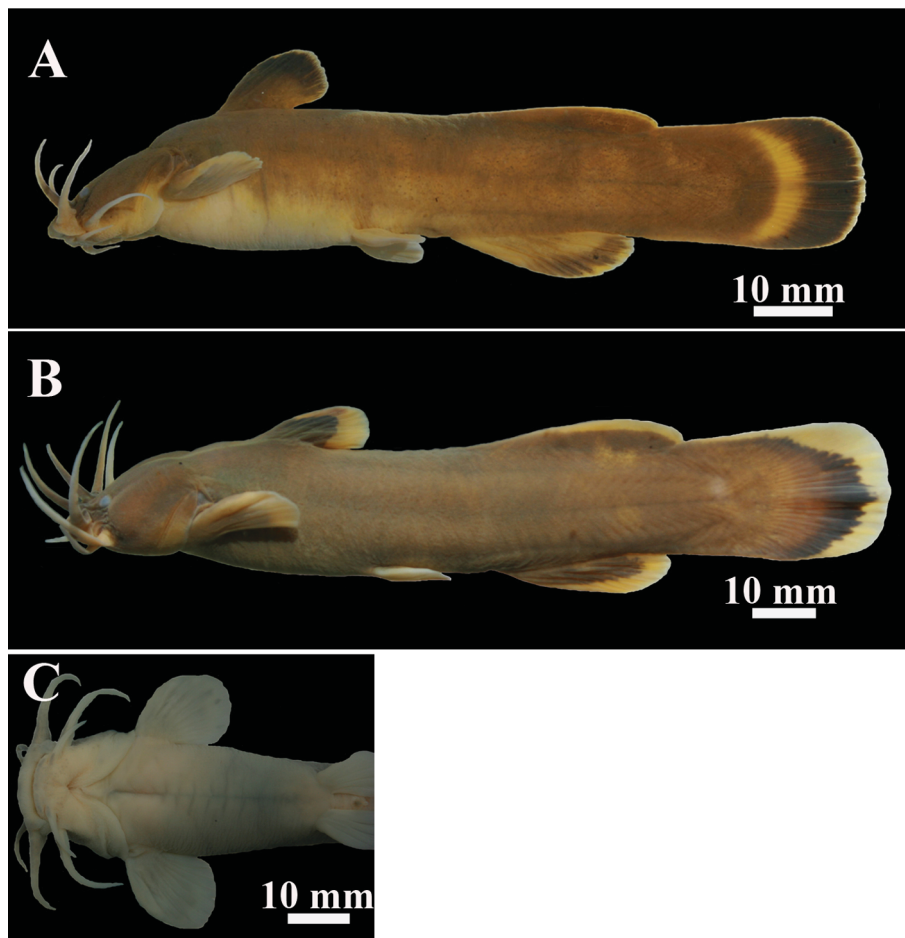
mandibular barbel long, reaching posterior margin of pectoral-fin base; medial mandibular barbel shortest of the four pairs of barbels, about half length of outer mental barbel, reaching to gill membrane.

**TABLE 1.** Morphometric and meristic data of *Liobagrus hyeongsanensis* (CNUC 38547–38567) and *L. mediadiposalis* (CNUC 37821–37838). H, holotype.

	<i>L. hyeongsanensis</i>					<i>L. mediadiposalis</i>			
	H	n	range	mean	SD	n	range	mean	SD
Standard length (mm)	84.1	20	57.1–84.1	68.9	6.0	18	73.5–100.3	85.4	7.7
In percents of standard length									
Preocciput length	19.1	20	18.3–22.3	19.6	1.1	18	17.9–20.3	19.2	0.6
Predorsal length	28.2	20	27.8–31.3	29.4	1.1	18	28.4–31.4	30.3	0.8
Prepectoral length	18.7	20	18.7–21.4	19.9	0.7	18	20.6–23.3	22.0	0.8
Prepelvic length	45.8	20	45.4–51.4	47.4	1.6	18	44.2–49.0	46.0	1.2
Length from occiput to dorsal-fin origin	9.4	20	9.3–12.9	10.3	0.8	18	10.3–13.3	11.7	0.8
Length from pectoral-fin origin to dorsal-fin origin	15.2	20	13.8–17.7	15.7	1.0	18	14.8–23.9	16.9	1.9
Length from pectoral-fin origin to pelvic-fin origin	28.3	20	27.5–34.4	30.2	2.3	18	25.4–28.5	27.0	0.9
Length from dorsal-fin origin to pelvic-fin origin	24.7	20	24.6–31.9	27.6	2.3	18	23.0–25.7	24.7	1.0
Length from pelvic-fin origin to adipose-fin origin	22.2	20	15.9–26.0	20.0	2.3	18	18.1–23.5	20.4	1.4
Length from pelvic-fin origin to anal-fin origin	16.6	20	12.1–16.6	14.1	1.2	18	15.3–20.9	17.9	1.5
Anal-fin base length	16.3	20	15.5–28.1	17.9	2.6	18	14.7–18.6	16.8	1.1
Dorsal-fin base length	8.3	20	7.8–10.9	9.0	0.8	18	7.7–10.4	9.6	0.6
Occiput to pectoral-fin origin	11.0	20	10.4–13.3	11.6	0.8	18	11.9–13.4	12.5	0.5
Interorbital width	7.4	20	5.6–7.8	6.6	0.5	18	6.2–7.5	6.7	0.3
Body width at pectoral-fin origin	16.9	20	15.5–17.9	16.5	0.6	18	17.1–20.0	18.5	0.7
Body width under dorsal-fin origin	13.6	20	13.4–19.3	15.5	1.6	18	13.0–16.5	14.9	0.9
Head width	19.9	20	16.4–19.9	18.0	0.9	18	17.5–19.6	18.5	0.6
Pectoral spine length	3.7	20	3.7–6.5	5.2	0.8	18	9.0–12.2	10.3	1.0
Dorsal spine length	3.3	20	3.2–6.8	4.7	0.9	18	5.5–8.9	7.4	1.0
Caudal-fin length	17.3	20	14.9–18.2	17.0	0.8	18	15.6–20.6	18.8	1.4
Maxillary-barbel length	20.1	20	18.2–22.6	20.9	1.1	18	17.5–24.5	21.0	1.6
Nasal-barbel length	12.3	20	9.4–14.5	12.3	1.3	18	10.1–15.6	12.7	1.3
Outer-mental barbel length	16.6	20	13.4–18.1	16.0	1.2	18	12.4–18.6	15.2	1.7
Inner-mental barbel length	7.2	20	6.5–10.6	8.9	1.2	18	7.4–9.1	8.3	0.5

Dorsal fin with II, 6 rays; origin closer to snout tip than to anal-fin origin, its posterior margin convex. Dorsal-fin spine a little shorter than pectoral-fin spine. Adipose fin base long, as long as or slightly exceeding anal-fin base length, confluent with caudal fin, its posterior margin convex. Pectoral fin with I, 7 rays, its origin anterior to vertical from posterior margin of operculum, partially covered by opercular membrane. Pectoral-fin spine sharp, short, with 2 (5), 3 (16) serrations on posterior edge. Pelvic fin with i, 5 rays; short, its origin located midway between dorsal and adipose fins, its tip not reaching base of anal fin. Anal fin with 15 (2), 16 (5), 17 (11), or 18 (3) rays, its distal margin rounded; anal fin short, origin slightly posterior to vertical through adipose-fin origin, posterior tip of anal fin not reaching beyond posterior margin of adipose fin. Caudal fin subtruncate, rounded. Vertebral column 38 (1), 39 (10), 40 (9), or 41 (1) post-Weberian elements. Gill rakers 6–8.

**Coloration.** See Figure 1 for general appearance. In life (Fig. 1): body generally brownish yellow, fading to light yellow on ventral surface, without distinct markings. All barbels pale gray. All fins with similar color to body, without any other markings.



**FIGURE 2.** *Liobagrus somjinensis* (A), CNUC 39019, 87.7 mm SL, Somjin River, South Korea; *L. mediadiposalis* (B, C), CNUC 39020, 95.1 mm SL, Nakdong River, South Korea.

**Distribution.** *Liobagrus hyeongsanensis* is restricted to the rivers flowing to the eastern coast of Gyeongsangbuk-do, South Korea: Upper Hyeongsan and Taehwa Rivers (Fig. 4).

**Sexual dimorphism.** The adductor mandibulae in males is greatly expended during the spawning season, from late April to June.

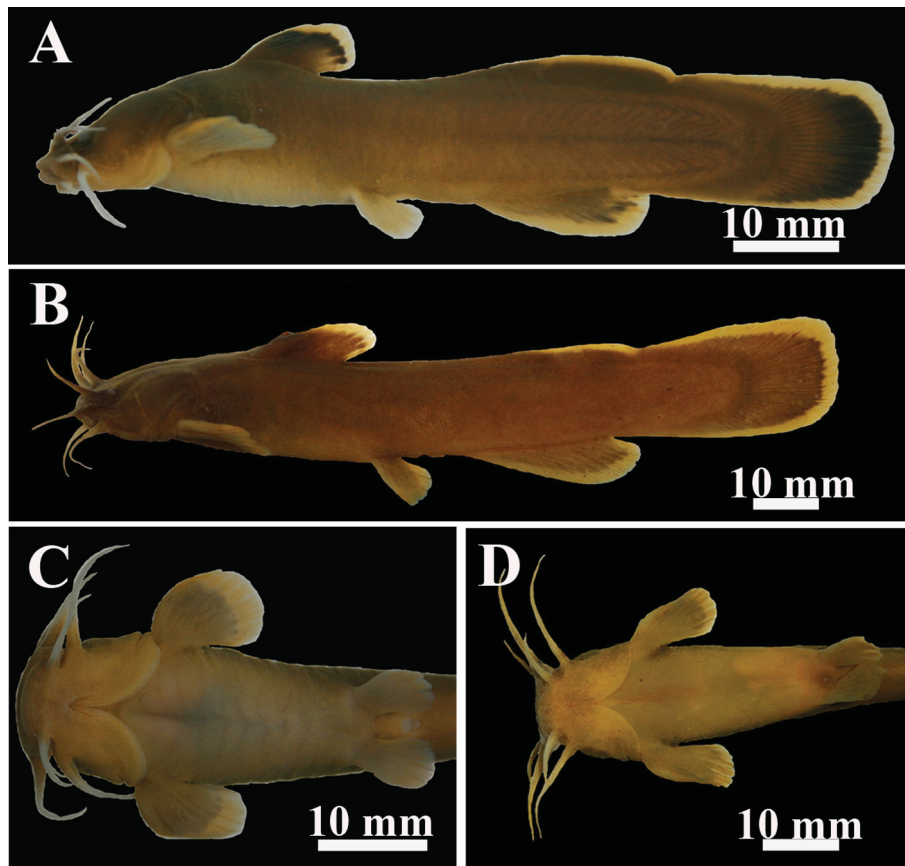
**Etymology.** Named after the Hyeongsan River, the type locality. We propose the Korean name Donbang-Jaga-sari for this species.

**Biology and habitat.** *Liobagrus hyeongsanensis* is small, nocturnal and benthic. It inhabits the bottom stratum of running waters with moderately fast currents, in upper streams and valley streams. It is generally seen in shallow waters (0.3–0.8 m deep) with large or small stony or pebbly substrates. The spawning season is from late April to June. The adult females do not exceed 90.0 mm SL and lay a small number of eggs (60–110), 2.8–3.3 ( $3.1 \pm 0.2$ ) mm in diameter.

## Discussion

For more than a century, only three species of *Liobagrus* were known from the Korean Peninsula: *L. andersoni*, *L. mediadiposalis*, and *L. obesus* (Regan 1908c; Mori 1936; Son *et al.* 1987). Populations of *Liobagrus mediadiposalis* show marked variation in coloration as well as meristic and morphometric data. Close study of one such population, with a crescent-shaped band on the caudal fin and a pectoral-fin ray count of I, 6–7, resulted in its

recognition as a distinct species, *Liobagrus somjinensis* (Park & Kim 2010). While studying other populations of *Liobagrus mediadiposalis* in rivers and streams throughout Korea, we discovered an unnamed species clearly distinguishable from all its congeners.



**FIGURE 3.** *Liobagrus andersoni* (A, C), CNUC 39021, 71.5 mm SL, Han River, South Korea; *L. obesus* (B, D), CNUC 39022, 95.5 mm SL, Mankyeong River, South Korea.

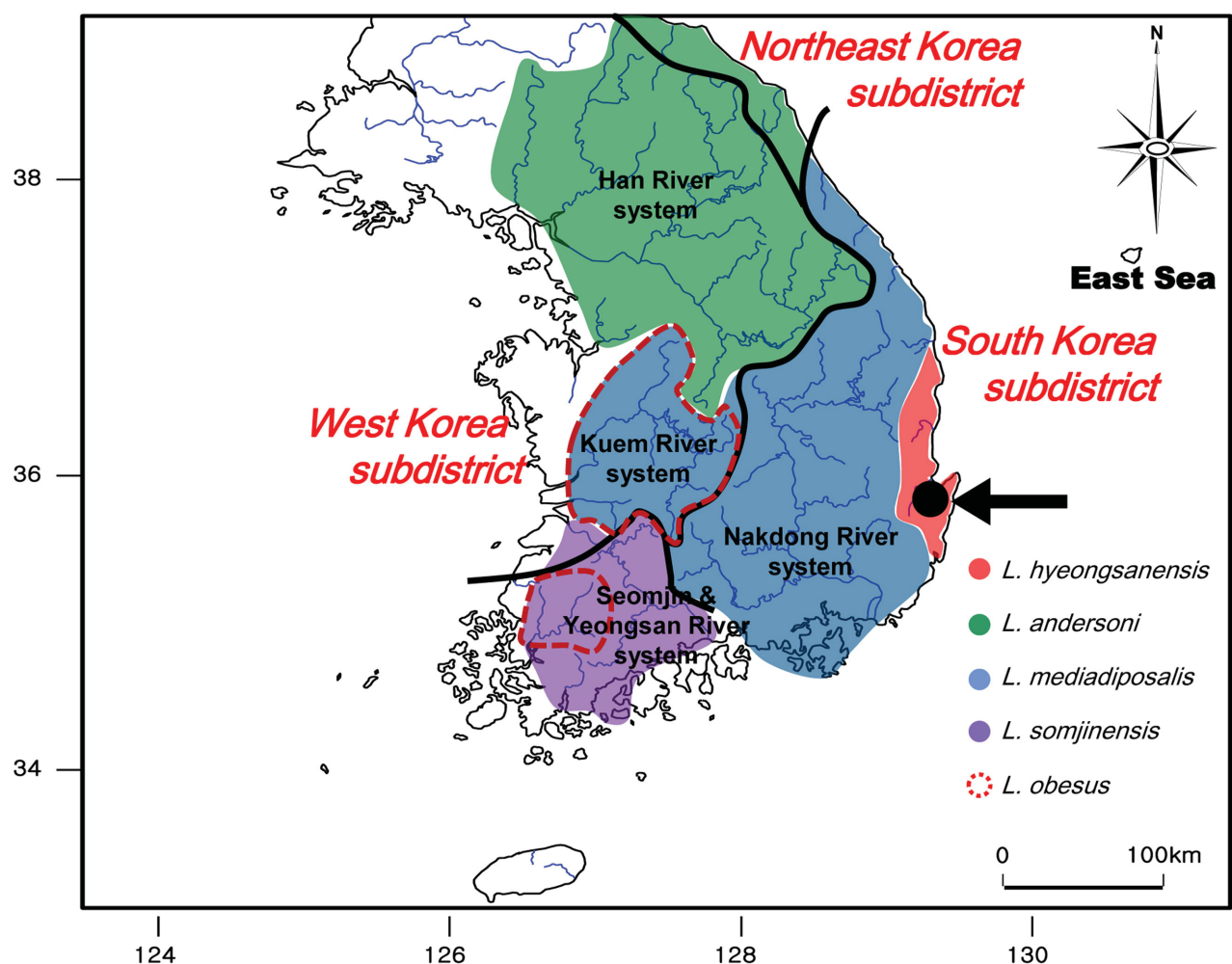
Compared with the original descriptions of *Liobagrus* (Hilgendorf 1878; Günther 1892; Regan 1904, 1908a, b, c; Oshima 1919; Nichols 1926; Wu 1930; Tchang 1935; Mori 1936; Son *et al.* 1987; Wright & Ng 2008; Park & Kim 2010) and based on coloration and meristic and morphometric data, we confirmed that *L. hyeongsanensis* is a species distinct from *L. mediadiposalis*. Of the Korean torrent catfishes, three species, *Liobagrus hyeongsanensis*, *L. somjinensis*, and *L. mediadiposalis* (Figs. 1–2), have the lower jaw shorter than the upper jaw, whereas *L. andersoni* and *L. obesus* have both jaws of equal length (Fig. 3). In particular, the number of serrations on the pectoral fin is 2–3 (mostly 3) in *L. hyeongsanensis* and 3–5 in *L. obesus*. Meanwhile, *Liobagrus andersoni* has 0–3 smaller or vestigial serrae. *Liobagrus hyeongsanensis* is a small-sized species with an overall brownish-yellow color over its entire body and fins (Fig. 1). In contrast, *Liobagrus somjinensis* has a broad vertical yellowish crescent-shaped band on the caudal fin, with a deep black outer margin, in addition to a deep black outer margin on the dorsal and anal fins (Fig. 2A). *Liobagrus mediadiposalis* has deep yellow outer margins on the black inner margins of all fins (Fig. 2B). *Liobagrus hyeongsanensis* is a small fish, reaching up to 90 mm SL (vs. 180 mm SL in *L. somjinensis* and *L. mediadiposalis*). *Liobagrus hyeongsanensis* has 2–3 (mostly 3) serrations on the pectoral fin (vs. 4–6 in *L. somjinensis* and *L. mediadiposalis*), 50–54 on the caudal-fin rays (vs. 57–61 in *L. somjinensis* and *L. mediadiposalis*), a relatively short pectoral spine (3.7–6.5 % SL, vs. 9.1–13.1% in *L. somjinensis* and 9.0–12.2% in *L. mediadiposalis*), and a thin body width at pectoral-fin base (15.5–17.9 % SL, vs. 17.3–19.6% in *L. somjinensis* and 17.1–20.0% in *L. mediadiposalis*). *Liobagrus hyeongsanensis* has a shorter lower than upper jaw, in contrast to its congeners (vs. lower jaw longer in *L. kingi*, *L. marginatus* and *L. marginatoides*; lower jaw of equal length in *L. andersoni*, *L. obesus*, *L. nigricauda*, *L. aequilabris* and *L. formosanus*). *Liobagrus hyeongsanensis* is further distinguished from *L. anguillicauda* and *L. nantoensis* by having 4–6 serrations on the posterior edge of the pectoral-fin spine (vs. serrations absent) (Table 2).

**TABLE 2.** Comparison of *Liobagrus hyeongsanensis* and its two congeners based on present study.

	*Caudal-fin ray count	Gill raker count	Number of serrations on the pectoral fin	Number of eggs per gravid female	Maximum standard length (mm)	A vertical crescent band on the caudal fin
<i>L. mediadiposalis</i>	57–61	7–11	4–6	130–200	< 180	absent
<i>L. somjinensis</i>	57–61	7–9	4–6	134–230	< 180	present
<i>L. hyeongsanensis</i> <b>sp.nov.</b>	50–54	6–8	2–3	60–110	< 90	absent

\*Includes principal caudal-fin rays, dorsal and ventral procurent caudal-fin rays.

*Liobagrus hyeongsanensis* is allopatrically distributed in smaller river systems including rivers and tributaries of the southeastern coast of Korea, compared to *L. somjinensis* and *L. mediadiposalis*. *Liobagrus somjinensis* inhabits rivers flowing to the western coast and some rivers flowing to the south coast, while *L. mediadiposalis* has an extended distribution, including some rivers inhabited by *L. somjinensis* (Fig. 4). *Liobagrus andersoni* is restricted to the Han River system, while *L. obesus* inhabits the western river systems of Keum, Yeongsan and Mangyeong River systems (Fig. 4). DNA analysis has also made it clear that the above three populations are separated well above the species level (Kim *et al.* 2006; Kim 2013).



**FIGURE 4.** South Korea, showing distributions of *Liobagrus hyeongsanensis*, *L. somjinensis*, *L. mediadiposalis*, *L. obesus*, and *L. andersoni*. Dense black lines: Baekdudaegan mountain range, showing three biogeographical ranges of ichthyofaunal endemisms in the Korean Peninsula (modified from Kim 1997).

The Korean Peninsula has a long mountain region, the Baekdudaegan, consisting of at least 12 mountain ranges extending from North Korea to South Korea (Fig. 4). These hills were formed by active orogenic events

from the early Triassic to the Jurassic and from the late Oligocene to the early Miocene (Chough *et al.*, 2001; Sohn *et al.*, 2001). On this basis, the biogeographical distributions of freshwater fish fauna on the Korean Peninsula is characterized by three biogeographical regions (Northeast, West, and South Korea subdistricts) based on the endemic species of several large mountain ranges, which may serve on vicariant barriers or lead to allopatric distributions (Mori 1936; Kim 1997) (Fig. 4). In particular, the water systems (the upper Hyeongsan and Taehwa Rivers of the South Korea subdistrict) inhabited by *Liobagrus hyeongsanensis* are unique in that two other endemic fishes, *Squalidus multimaculatus* and *Iksookimia yongdokensis*, are restricted to these systems (Kim & Park 2002). This pattern of biogeographical isolation in the range encompassing basins of the Hyeongsan and Taehwa Rivers may be caused by the vicariant barrier of mountain ranges associated with a small isolated patch of middle Miocene marine sediment (Lee 1988). Some mountain ranges between the West and South subdistricts play an important role as a strong and long-term barrier to prevent recurrent gene flow and to split *Coreoleucisucs splendidus* populations into two genetically discrete subdistrict populations (Kim *et al.*, 2012). These mountain ranges appear to have effectively isolated species in different river systems, leading to a high level of endemism. The geographical pattern of speciation in *Liobagrus* has been reported previously also for other Korean freshwater fishes, including species in the families Cobitidae and Cyprinidae (Kim 1997; Kim & Park 2002; Kim *et al.* 2005; Park & Kim 2010).

## Comparative material

- Liobagrus andersoni*: CNUC 9441–3 (3), 86.3–90.9 mm SL; South Korea: Bongpyeong-myeon, Pyeongchang-gun, Gangwon-do: Han River; Y.M. Son, 15 Jul 1985. CNUC 39021 (1), 71.5 mm SL; South Korea: Cheongchen-myeon, Goesan-gun, Chungcheongbuk-do: Han River; J.Y. Park & H.S. Kim, 6 Jul 2015.
- Liobagrus obesus*: CNUC 936–40 (5), 58.2–81.8 mm SL; South Korea: Simcheon-myeon, Yeongdong-gun, Chungcheongbuk-do, Geum River; Y. Choi, 28 August 1978. CNUC 9434, 9436, 9439 (3), 82.3–94.8 mm SL; same locality; collector unknown, 27 May 1985. CNUC 39022 (1), 95.5 mm SL; South Korea: Gosan-myeon, Gosan-gun, Jellabuk-do: Mankyeong River; J.Y. Park & H.S. Kim, 6 Jul 2015.
- Liobagrus mediadiposalis*: CNUC 37821–38 (18), 73.9–100.3 mm SL; South Korea: Sicheon-myeon, Sancheong-gun, Gyeongsangnam-do: Nakdong River; J.Y. Park & S.H. Kim, 23 Sep 2009. CNUC 1019–20 (2), 55.6–64.7 mm SL; South Korea: Imgok-dong, Gwangsan-gu, Gwangju: Yeongsan River; W.O. Lee, 18 Jun 1988. CNUC 1025–8 (4), 78.9–108.9 mm SL; South Korea: Hamyang-gun, Gyeongsangnam-do: Nakdong River; collector unknown, 1 Oct 1985. CNUC 1035–8 (4), 82.4–109.5 mm SL; South Korea: Yurim-myeon, Hamyang-gun, Gyeongsangnam-do: Nakdong River; collector unknown, 2 Oct 1978. CNUC 1801–5 (5), 83.4–107.8 mm SL; South Korea: Macheon-myeon, Hamyang-gun, Gyeongsangnam-do: Nakdong River; collector unknown, 1 Oct 1977. CNUC 1806–8 (3), 81.9–102.6 mm SL; South Korea: Cheoncheon-myeon, Jangsu-gun, Jeollabuk-do: Geum River; collector unknown, 6 Jun 1978. CNUC 1809 (1), 89.4 mm SL; South Korea: Samcheok-si, Gangwon-do: Samcheokoship Stream; collector unknown, 21 June 1975. CNUC 9445 (1), 123.7 mm SL; South Korea: Mungyeong-eup, Mungyeong-si, Gyeongsangbuk-do: Nakdong River; collector unknown, 25 Sep 1981.
- Liobagrus somjinensis*: CNUC 37749 (1), 99.4 mm SL; South Korea: Geumji-myeon, Namwon-si, Jeollabuk-do: Somjin River; J.Y. Park & S.H. Kim, 26 Jan 2010. CNUC 37750–65 (16), 74.1–100.6 mm SL; same data as holotype. CNUC 37766–9 (4), 74.8–91.3 mm SL; South Korea: Jukgok-myon, Gokseong-gun, Jeollanam-do: Somjin River; J.Y. Park & S.H. Kim, 26 Jan 2010.
- Liobagrus reini*: CNUC 38971–38972 (2), 48.9–64.5 mm SL; Japan: Sanda, Hyogo Prefecture; collector unknown, 20 Jan 2011.
- Liobagrus fimosanus*: NTHUB 01763 (7), 56.6–86.4 mm SL; Twiwan: Puli, Nantou County; collector unknown, 25 Mar 1999. NTHUB 01766 (1), 73.3 mm SL; Twiwan: Changhua County; collector unknown, 1997.
- L. nigricauda*: IHB 0110, IHB 0114, IHB 0366, IHB 0379, IHB 83135, IHB 920503, IHB 8840595, IHB 8841429 (13), 54.5–94.2 mm SL; China: Sichuan Province; collector unknown, 1979.
- L. marginatoides*: CAS 5224, CAS 5227, CAS 5230, CAS 5234, CAS 5332 (5), 51.8–58.6 mm SL; China: Sichuan Province; collector unknown, 1952.
- L. styani*: CAS 770020–4 (5), 52.0–95.3 mm SL; China: Shanxi Province; collector unknown, 1983. CAS 80-1317,

CAS 80-0897, CAS 80-1204–5, CAS 90-0205, CAS 90-0207, CAS 90-0209, CAS 81-1371, CAS 81-1373 (9), 67.5–101.5 mm SL; China: Jiangxi Province; collector unknown, 1990.  
*L. marginatus*: CAS 177637–177684 (48), 83.1–116.2 mm SL; China: Sichuan Province; collector unknown, 22 Jun 2008.  
*L. anguillicauda*: CAS 131004–131039 (36), 87.9–98.6 mm SL; China: Anhui Province; collector unknown, 1997.  
*L. kingi*: CAS 130745–130747 (3), 82.1–86.1 mm SL; China: Chongqing Shi; collector and date unknown.

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## References

- Chen, X. & Lundberg, J.G. (1995) *Xiurenbagrus*, a new genus of amblycipitid catfishes (Teleostei: Siluriformes), and phylogenetic relationships among the genera of Amblycipitidae. *Copeia*, 1995, 780–800.  
<http://dx.doi.org/10.2307/1447027>
- Chough, S.K., Kwon, S.T., Ree, J.H. & Choi, D.K. (2000) Tectonic and sedimentary evolution of the Korean peninsula: a review and new view. *Earth-Science Reviews*, 52, 175–235.  
[http://dx.doi.org/10.1016/S0012-8252\(00\)00029-5](http://dx.doi.org/10.1016/S0012-8252(00)00029-5)
- Günther, A. (1892) Appendix?. In: A.E. Pratt (Ed.), *List of the species of reptiles and fishes collected by Mr. A.E. Pratt on the upper Yang-tze-kiang and in the province Sze-Chuen, with description of the new species*. London, Longmans, Green and Company, pp. 238–350.
- Hilgendorf, F.M. (1878) Einige neue japanische Fischgattungen. *Sitzungsberichte der Gessellschaft Naturforschender Freunde zu Berlin*, 1878, 404–457. [In German]
- Hubbs, C.L. & Lagler, K.F. (1964) *Fishes of the Great Lakes Region*. The University of Michigan Press, Ann Arbor, 213 pp.
- Kim, K.Y., Nam, Y.K. & Bang, I.C. (2012) Phylogeny and divergence time estimation of *Coreoleuciscus splendidus* populations (Teleostei: Cypriniformes) endemic to Korea based on complete mitogenome sequences. *Genes & Genomics*, 34, 149–156.  
<http://dx.doi.org/10.1007/s13258-011-0098-x>
- Kim, I.S. (1997) *Illustrated encyclopedia of fauna and flora of Korea Vol. 37 freshwater fishes*. Ministry of Education, Seoul, 613 pp. [In Korean]
- Kim, I.S. & Park, J.Y. (2002) *Freshwater fishes of Korea*. Kyohak Publishing Company, Ltd, Seoul, 465 pp. [In Korean]
- Kim, I.S., Choi, Y., Lee, C.L., Lee, Y.J., Kim, B.J. & Kim, J.H. (2005) *Illustrated Book of Korean Fishes*. Kyohak Publishing Company, Ltd, Seoul, 615 pp. [In Korean]
- Kim, M.J., Han, S.H., Yang, H.Y., Jo, M.R., Chung, S.C. & Song, C.B. (2006) Evolutionary relationship of *Liobagrus mediadiposalis* (Teleostei: Amblycipitidae) population in Korean inferred from cytochrome *b* DNA sequence. *Korean Journal of Ichthyology*, 18, 329–338. [In Korean]
- Kim, S.H. (2013) *Taxonomic revisions of the Genus Liobagrus (Siluriformes: Amblycipitidae) from Korea*. Doctoral dissertation, Chonbuk National University, Jeonju, 125 pp. [In Korean]
- Lee, D.S. (1988) *Geology of Korea*. Kyohak Publishing Company, Ltd, Seoul, 514 pp. [In Korean]
- Mori, T. (1936) Description on new genera and three new species of silurioidea from Choseon. *Zoological Magazine*, 48, 671–675. [In Japanese]
- Ng, H.H. & Kottelat, M. (2000) A review of the genus *Amblyceps* (Osteichthyes: Amblycipitidae) in Indochina, with descriptions of five new species. *Ichthyological Exploration of Freshwaters*, 11, 335–348.
- Nichols, J.T. (1926) Some Chinese freshwater fishes. XVIII. New species in recent and earlier fukien collection. *American Museum Novitates*, 169, 1–7.
- Oshima, M. (1919) Contributions to the study of the freshwater fishes of Formosa. *Annals of the Carnegie Museum*, 12, 169–328.
- Park, J.Y. & Kim, S.H. (2010) *Liobagrus somjinensis*, a new species of torrent catfish (Siluriformes: Amblycipitidae) from Korea. *Ichthyological Exploration of Freshwaters*, 21, 345–352.
- Regan, C.T. (1904) On a collection of fishes made by Mr. J. Graham at Yunnan Fu. *Annals and Magazine of Natural History (Ser. 7)*, 13, 190–194.
- Regan, C.T. (1908a) Description of new fishes from Lake Candidius Formosa, collected by Dr. A. Moltrecht. *Annals and Magazine of Natural History (Ser. 8)*, 10, 358–360.
- Regan, C.T. (1908b) Descriptions of new freshwater fishes from China and Japan. *Annals and Magazine of Natural History (Ser. 8)*, 1, 149–153.

- Regan, C.T. (1908c) *On freshwater fishes from Corea*. Proceedings of the Zoological Society of London, London, pp. 59–63.
- Son, Y.M., Kim, I.S. & Choo, I.Y. (1987) A new species of torrent catfish, *Liobargus obesus* from Korea. *Korean Journal of Limnology*, 20, 21–29.
- Shon, Y.K., Rhee, C.W. & Shon, H. (2001) Revised stratigraphy and reinterpretation of the Miocene Pohang basin fill, SE Korea: sequence development in response to tectonism and eustasy in a back-arc basin margin. *Sedimentary Geology*, 143, 265–285.  
[http://dx.doi.org/10.1016/S0037-0738\(01\)00100-2](http://dx.doi.org/10.1016/S0037-0738(01)00100-2)
- Tchang, T.L. (1935) A new catfish from Yunnan. *Bulletin of the Fan Memorial Institute of Biology, Peiping (Zoological Series)*, 6, 95–97.
- Wright, J.J. & Ng, H.H. (2008) A new species of *Liobagrus* (Siluriformes: Amblycipitidae) from South China. *Proceedings of the Academy of Natural Sciences of Philadelphia, Philadelphia*, 157, 37–43.  
[http://dx.doi.org/10.1635/0097-3157\(2008\)157\[37:ANSOLS\]2.0.CO;2](http://dx.doi.org/10.1635/0097-3157(2008)157[37:ANSOLS]2.0.CO;2)
- Wu, H.W. (1930) Description de poissons nouveaux de Chine. *Bulletin du Muséum National d'histoire Naturelle (Ser. 2)*, 2, 255–259.
- Zhao, Y., Lan, J. & Zhang, C. (2004) A new species of amblycipitid catfish, *Xiurenbagrus gigas* (Teleostei: Siluriformes), from Guangxi, China. *Ichthyological Research*, 51, 228–232.  
<http://dx.doi.org/10.1007/s10228-004-0220-z>